NHDOT SPR2 PROGRAM
RESEARCH PROGRESS REPORT

Project # SPR 26962U	Report Period Year 2021
	XQ1 (Jan-Mar) ☐Q2 (Apr-Jun) ☐Q3 (Jul-Sep) ☐Q4 (Oct-Dec)

Project Title:
Improved Practices for Determining the Infiltration Characteristics of Soils for Design of Stormwater BMPs

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Project Start Date: April 17, 2019	**Project End Date:** June 30, 2021	**Project schedule status:** On schedule ☐ Ahead of schedule **X** Behind schedule

Brief Project Description:

Soil infiltration data are utilized by the NH Department of Transportation (NHDOT) to assess the suitability of a site for various stormwater best management practices (BMPs) and to properly size and design a treatment area. With the recent issuance of EPA's final Municipal Separate Storm Sewer System (MS4) permit rules, the need for such testing is expected to increase.

In order to estimate infiltration rates, the NHDOT currently utilizes a variation of the borehole infiltration test prescribed in the NH Department of Environmental Services (NHDES) Alteration of Terrain (AoT) rules using conventional geotechnical drilling equipment. Existing testing protocols are labor intensive and time consuming, often taking 4 hours or more to complete a single test interval (depth). This is particularly inefficient if multiple depths require testing, e.g. if the preferred "bottom of practice" has not been established. In addition, the existing test method may not replicate field conditions and is prone to missing important features in the soil profile. Other available tests either require a constant head that is difficult to maintain in the field or have limitations associated with the effective depth of the test or the level of the groundwater table. Research is needed to evaluate alternative methods and improve Department practices to allow for more effective design of BMPs.

A permeafor device, originally developed in France, has been identified as a potential alternative to current practice. The permeafor is an in-situ hydraulic profiling tool that provides a quick estimate of the permeability profile of soil layers and can be adapted to conventional drilling equipment.

The objectives of this research are as follows:

1. Review available permeafor drawings, adapt design features to be compatible with NHDOT equipment and operations, and fabricate a prototype for further evaluation in the field.

2. Compare the performance of the permeafor alongside existing test method.

3. Recommend and implement design modifications as a result of initial testing.

4. Provide a workable permeafor device suitable for implementation on NHDOT projects.

The scope of work for this research includes the following major tasks, with primary responsibility indicated in parentheses:

1. Obtain available permeafor plans, shop drawings, and details. (UNH)

2. Recommend design changes to ensure compatibility with geotechnical drilling equipment operated by the NHDOT. (UNH/NHDOT)

3. Fabricate one or more permeafor devices. A total of two (2) devices are anticipated as part of the research. It is suggested that a single device be fabricated for initial testing and the second device be fabricated to incorporate lessons learned after the initial testing. (UNH)

4. Procure required pumps, flowmeters, and other ancillary equipment. (UNH)

5. Calibrate the permeafor with grain-size analyses and permeability water tests performed in the laboratory. (UNH)

6. Identify field sites for testing. A minimum of three (3) sites will be evaluated, with multiple depths tested at each site. Sites will be chosen where NHDOT-obtained infiltration data has been collected or will be collected during the research. (UNH/NHDOT)

7. Conduct initial field testing at one or two sites. (UNH/NHDOT)

8. Review existing formula(s) used to convert field data to the Design Infiltration Rate needed for BMP design. (UNH)

9. Conduct final field testing at remaining sites. (UNH/NHDOT)

10. Recommend modifications to formula(s) used to convert field data to the Design Infiltration Rate needed for BMP design. (UNH)

11. Provide a final report summarizing the research and containing recommendations for implementation by NHDOT. (UNH)

Progress this Quarter (include meetings, installations, equipment purchases, significant progress, etc.):

During this past quarter, further investigation of water flow from various permeafor configurations into soil formations of varying permeabilities and stratigraphies was continued through finite element analysis, using the Plaxis 2D software. This study will help support the estimated hydraulic conductivities obtained from the various test sites in different soil conditions using the permeafor. Further laboratory testing was done on samples retrieved from the test sites to assess the validity of the laboratory constant head testing that were performed on smaller size test specimens. The permeafor field testing control and acquisition software are currently being updated to help simplify and standardize the testing procedures before future NHDOT work. The LabVIEW user interface is being recoded to automate the control and acquisition system during driving of the permeafor as well as during permeafor testing. The system is being configured to be user-friendly and less operator sensitive.

Items needed from NHDOT (i.e., Concurrence, Sub-contract, Assignments, Samples, Testing, etc...):

We will need further drilling support at additional test sites that can be used for broadening the scope of material tested but especially for training of NHDOT personnel on the use and operation of the permeafor testing and acquisition system. In addition to all sites tested to date, borehole infiltration tests are still needed for comparison to our permeafor results. These borehole infiltration tests need to be carried out by NHDOT personnel. This testing should be carried out in May or June of this year.

Anticipated research next three (3) months:

With the spring months approaching, we would like to have the opportunity to test two additional sites. This would allow testing of the new and more autonomous software. This simpler permeafor testing and data acquisition system will also be used for training of NHDOT personnel. We anticipate finalizing our finite element analysis and completing several sections of the final report. Construction of an updated second permeafor probe will also be completed. We also anticipate ordering other ancillary support equipment such as a flow pump and a flowmeter.

Circumstances affecting project:

Availability of NHDOT drilling equipment and personnel have been difficult during this Covid pandemic. Nevertheless, we managed to complete our testing to meet the contract requirements. Although the results to date are very encouraging, we would still like to perform additional testing to train NHDOT personnel on the use of the permeafor. We have requested a no-cost extension to allow us to complete the final report, hold NHDOT training and, finish the construction of the new probe and the ancillary equipment.

Tasks (from Work Plan)	Planned % Complete	Actual % Complete
Task 1: Permeafor plans	100	100
Task 2: Permeafor – drill rig compatibility	100	100
Task 3: Permeafor probes construction	100	60
Task 4: Ancillary equipment purchases and assembly	50	50
Task 5: Permeability tests in laboratory	90	90
Task 6: Site selection	100	100
Task 7: Conduct initial testing	100	100
Task 8: Review of existing formulas for analysis	80	80
Task 9: Conduct final testing	85	85
Task 10: Recommendations	70	70
Task 11: Final report	60	60

Barriers or constraints to implementing research results

None